Adopter categorization and level of adoption among protected cut flower growers

ABSTRACT

In India, Tamil Nadu occupies the first position in terms of area under flower cultivation then followed by Karnataka and West Bengal. Out of the 33 districts in Tamil Nadu, Krishnagiri district ranks first in cut flower production due to its suitability to climatic conditions. The cut flowers are by and large cultivated under protected conditions (poly greenhouse structure) to meet the quality standards as expected in the global trade arena. The present study was conducted to identify the adopter categories and their level of adoption with respect to protected cut flower cultivation technologies. An ex-post facto research design was used for the study. The first two intensive blocks (Thally & Hosur) cultivating cut flowers under protected methods were purposefully selected for the present study. From both blocks, six villages were selected, and the data were collected from 120 respondents among these twelve selected villages using a well-structured interview schedule. The collected data were analyzed using mean, standard deviation, cumulative frequency, and principal component analysis (PCA). The results of the adopter categorization showed that 40.83 percent of respondents belonged to the early majority and only 5.00 percent were innovators. The results regarding the overall adoption of protected cultivation by each adopter category reported that 54.17 percent of respondents had medium-level adoption, in that 44.61 percent and 30.77 percent were early majority and late majority, respectively. The majority of respondents have a medium-level adoption of protected cultivation, leaving potential for growth among early majority and late majority adopters. Targeted strategies and incentives should address their specific needs, and encouraging more innovators to adopt can drive widespread adoption.

***Keywords**: Adopter categories, Adoption level, Cut flowers, Protected cultivation technology*

1. INTRODUCTION

India is blessed with a variety of agro-climatic and ecological conditions that are conducive to cultivating every form of commercially important flowers typically seen in various regions of the world. The total area under flower cultivation in India is 267 thousand hectares. The average production of cut flowers is 791 thousand metric tonnes and loose flowers are 2095 thousand metric tonnes during 2021-22. India holds the second position in the production of flowers next to China (Anumala & Kumar, 2021)[1]. But India's flower export is not as expected, it is comparatively less. India ranks 14th position in exporting floriculture products by contributing 0.60 of the world's floriculture exports, which may be the result of shortcomings in upholding international quality standards, a lack of integrated cold chain management, and an unorganised market and distribution system. We can meet the international quality criteria for exporting flower products by implementing protected cultivation practises in the production of cut flowers. Because the cut flowers cultivated under a protected structure will results in enhanced yield and provide global quality standard products. According to the National Horticultural Database for 2014-15 (Ganguly, 2018, p.3.)[2]In India, Tamil Nadu is top in flower cultivation area, next followed by Karnataka and West Bengal. Floricultural products account for 3.2 percent of total horticultural crop exports (Ganguly, 2018, p.4.)[2].

In Tamil Nadu, Krishnagiri district holds the first place in protected cultivation (poly greenhouse structure). Though Krishnagiri district occupies first position in the state, only a 1,300-acre land area is under protected cultivation (SDH, Krishnagiri, 2022)[3]. According to the district statistics (SDH, Krishnagiri, 2022)[3], the total land area under horticultural crops is to the tune of 95,034 hectares in this, the area under cut flower cultivation is 8247 hectares. Out of which, the area under protected cultivation is only 1,060 acres (almost 13 %). In such a situation, the scope for enhancing areas under protected cultivation is very high in the near future. The Government takes many initiatives to improve the adoption of protected cultivation practices among cut flower growers. In spite of all the initiatives the adoption of protected cultivation practices among farmers is not satisfactory. For improving the adoption level of protected cultivation technologies this study aims to categorize the adopters based on the rate of adoption of protected cultivation technologies and analyse the adoption level of technologies by each category of adopters.

Objectives of the study

The objective of the study is to categorize the cut flower growers based on the rate of adoption on protected cultivation technology and to study the level of adoption on protected cultivation practices among cut flower growers.

2. MATERIAL AND METHODS

Krishnagiri district was purposively selected for the study. Secondary data on a list of cut flower growers under protected cultivation were collected from the Department of Horticulture, Hosur, and Thally blocks of the district. From both blocks, 12 villages were selected purposively. In those 12 villages, 120 respondents (cut flower growers with protected structures) were selected using a simple random sampling technique. Of that the 120 respondents, 42 were rose growers, 33 were carnation growers, 22 were chrysanthemum growers, and 23 were gerbera growers. A well-structured interview schedule was framed keeping in view the objectives of the study used for collecting primary data.

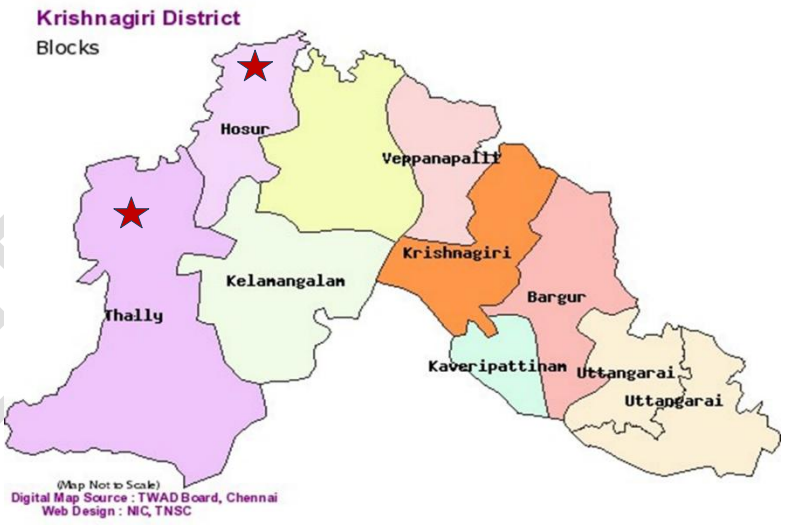

Fig 1. Map of the study area

The data collected for the study were analysed using descriptive statistics. Hejase & Hejase (2011) [4] contend that giving data meaning leads to useful information. Furthermore, according to Hejase and Hejase (2013) [5], "descriptive statistics deals with describing a collection of data by condensing the amounts of data into simple representative numerical quantities or plots that can provide a better understanding of the collected data" (p. 272). Therefore, this research reported results in the form of frequencies, percentages, means, and standard deviations in table form for simplicity. Also, the mean and standard deviation were used for categorizing the protected cut flower growers into different adopter

categories and the cumulative frequency method was used for depicting innovative S-curve by Prashanthi et.al., (2022) [6]. Principal component analysis was used to find the composite technology adoption index (CTAI) by and RAO, D. (2019) [7] to measure the level of adoption of the protected cultivation technologies.

$$CTAI_i = \sum_{j=1}^{30} w_{ij} x_{ij}$$

Where $CIAT_i$ is the composite technology adoption index of i^{th} farmer,

x_{ij} = adoption of recommended protected cultivation technology by i^{th} farmer,

If the farmer had adopted a suggested technology, the score would be 1; if none were adopted, the score would be 0.

w_{ij} = weight assigned to i^{th} technology through principal component analysis (PCA).

$$\mathbf{w_{ij} = m_i / \Sigma\, m_i}$$

m_i is the squared maximum eigenvalue of i^{th} technology,

$\Sigma\, m_i$ is the sum of the squared maximum eigenvalue of all the technologies.

The squared value of the highest eigenvalue found in any of the principal components for a particular technology was calculated. The variance is explained by each principal component, from which the largest eigenvalue for a given technology was derived and used to calculate the weighted eigenvalues. These weighted eigenvalues were standardised to have a total of one. The weight for a particular technology was determined by its standard eigenvalue.

3. RESULTS AND DISCUSSION

3.1. Adopter categorization based on the rate of adoption

The rate of adoption is the relative speed of adopting the innovation by members of a social system. It is generally measured as the number of individuals who adopted a new idea in a specified period, such as each year. In this study, it was determined on the basis of the time taken by the cut flower growers in adopting the protected cultivation technologies after they got aware of it. The time was measured in years. The data on the year of adopting the protected cultivation technology by cut flower growers since its introduction by the government in 2009 was collected. The data were analysed using mean and standard deviation.

Table 1. Adopter categorization of respondents based on year of adoption of protected cultivation technology in cut flower production
n=120

S. No.	Adopter categories	Year	Frequency	Percentage
1.	Innovators	≤ 2009	06	5.00
2.	Early adopters	2010-2012	16	13.33
3.	Early majority	2013-2016	49	40.83

4.	Late majority	2017-2019	28	23.33
5.	Laggards	2019-2023	21	17.50
Mean: 2016 & Standard deviation: 7.27				

From the results of Table 1, it could be found that the majority (40.83 %) of respondents belonged to the early majority category followed by a late majority (23.33 %), laggards (17.50%), early adopters (13.33%) and only (5.00%) of innovators. Results showed that the percentage of adopter categories deviate from Roger's adopter categories model in ideal conditions. The results are in conformity with the findings obtained by Mahajan *et.al.,(*2020)[8], Painkra, V. K. (2020)[9].

Possible reasons for deviation from normal adopter curve profound by Rogers

- The diffusion pathways and adoption pattern of protected cultivation technology may vary from other technologies. So, the adopter categories of protected cultivation deviate from the Rogers adopter categories.
- The adoption of protected cultivation technologies may be affected by regional or community-specific cultural and environmental factors. These elements could influence adopters' attitudes, values, and behaviour. It is also one of the possible reasons for deviation from ideal adopter categories.

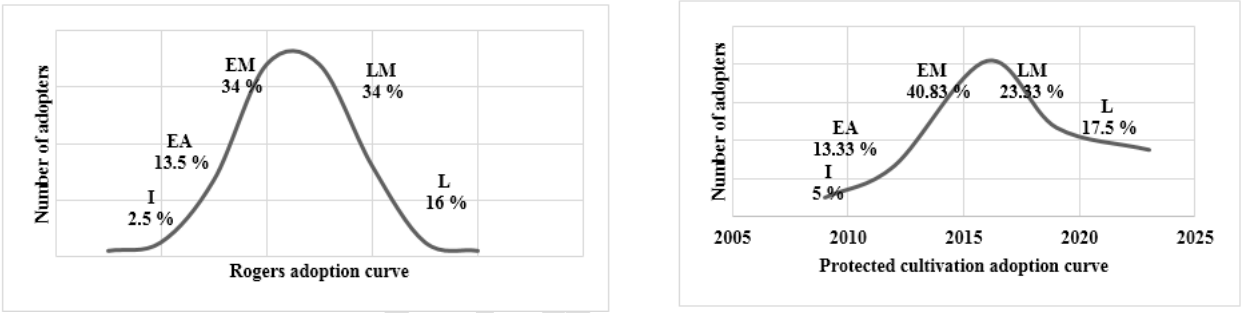

Fig. 2. Normal Rogers curve vs Adopter curve (Study)

From Figure 1, it can be observed that there was an increase in innovators, deviating from the normal curve. This increase can be attributed to the training provided by the Centre of Excellence for Cut Flowers, Thally, and the increased participation in social media, which have been the main driving forces behind the adoption of protected cultivation technology among innovators.

Similarly, the early majority category also experienced growth beyond the typical distribution of Rogers' normal curve. This can be attributed to the various governmental incentives offered, such as financial aid, technical training, and tax breaks, which have enticed people to adopt protected cultivation technology promptly. These incentives seem to have contributed to an increase in the number of early adopters compared to the ideal adopter category.

However, adoption by some farmers took more time due to the complexity of the technology and the high initial investment required. This delay in adoption might be the reason for the increase in the laggard category, which lies at the tail end of the adopter curve.

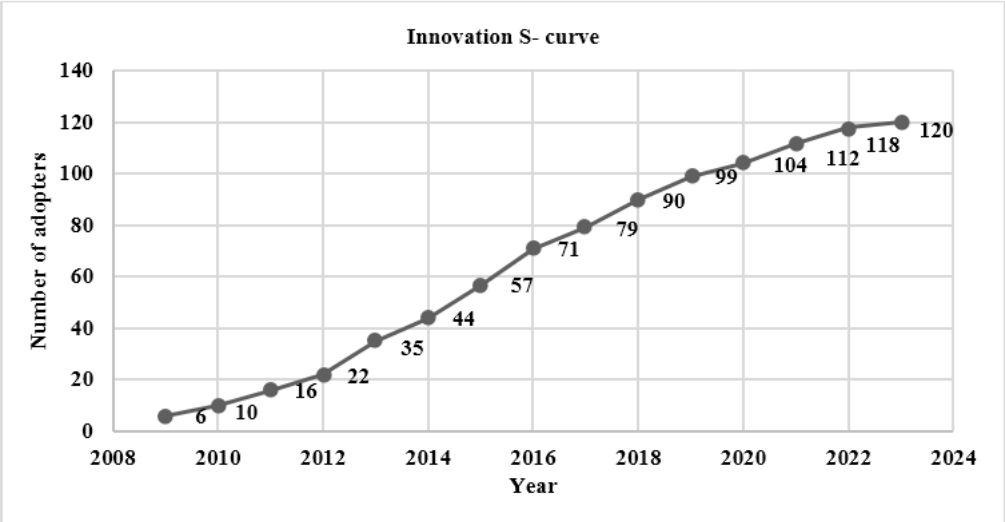

Fig. 3. Distribution of respondents based on rate of adoption

3.2. Level of Adoption

Table 2. Distribution of respondents based on the adoption level of recommended technologies under protected cultivation

(n=120)

S. No.	Protected cultivation technologies	Number	Frequency of Adopters (%)
1.	Shape (Saw tooth type greenhouse)	120	100.00
2.	Covering material (Plastic film greenhouse)	120	100.00
3.	Green house construction related aspects		
	Location	99	82.50
	Topography of land	119	99.17
	Accessibility of the site for market	76	63.33
	Orientation	67	55.83
4.	Light control		
	Florescent light	94	78.33
	Screening material	79	65.33
5.	Pest and pathogen control		

	IPM	73	60.83
	Yellow Sticky trap	79	65.83
	Dusting	37	30.83
	chemical spraying	92	76.67
6.	Sterilisation material (or) fumigators		
	Formalin	77	64.17
	Hydrogen peroxide (H2O2) with silver	53	44.17
7.	Green house cooling		
	Fog evaporative cooling	68	56.67
	Exhaust fan in end wall	65	54.17
	Thermostat	52	43.33
	Maintaining air space between two covering material	110	91.67
8.	Enrichment of CO_2	71	59.17
9.	Humidity(hygrometer)	59	49.17
10.	Root media preparation	71	59.17
11.	Drip irrigation	120	100.00
12.	Mist and sprinkler irrigation	95	79.17
13.	Soil testing	98	81.67
14.	Thermometer	43	35.83
15.	Fertigation system	120	100.00
16.	Plastic polyethylene mulching	46	38.33
17.	Post-harvest management technique		
	Maturity indices & harvesting	112	93.33
	Grading& packing	69	57.50
	Pre-cooling unit	68	56.67

It could be observed from Table 2, that all the respondents (100 %) had adopted the saw tooth type greenhouse and plastic film covering material, findings are similar in line with (Amrutrao, 2018)[10]. Hundred percent of the respondents (100 %) adopted drip irrigation and fertigation system, which is

similar to the results of Prakash, Kumar *et.al.,* (2021)[11]. The possible reason may be due to the perceived advantages of efficient nutrient management through fertigation (Irrigation coupled with water-soluble fertilizer) and regular contact with the extension officials of the state department of horticulture besides periodic follow-up by service providers and site inspection by the university scientist. Regarding greenhouse construction-related aspects 99.17 percent of respondents had adopted proper topography of land for constructing greenhouse and 82.5 percent of respondents completely adopted location aspect. The adoption rate of the correct orientation (north-south direction) was only 55.83 percent among the respondents. This lower adoption rate could possibly be attributed to the presence of different land shapes, which may have posed challenges or limitations for some farmers to implement the recommended orientation. In the case of control of light, 78.33 percent of respondents had adopted fluorescent light and 65.33 percent of them had adopted screening material. In the case of pest and pathogen control, chemical spraying, yellow sticky trap, integrated pest management, and dusting techniques 76.67 percent, 65.83 percent 60.83 percent, and 30.83 percent had adopted respectively. Regarding sterilization material (or) fumigators use, formalin 64.17 percent and hydrogen peroxide (H_2O_2) with silver 44.17 percent of respondents had adopted. Regarding the greenhouse cooling aspect, maintaining air space between two covering materials, fog evaporative cooling, exhaust fan in the end wall, and thermostat, 91.67 percent, 56.61 percent, 54.17 percent, 43.33 percent of respondents had adopted respectively. 59.17 percent of respondents had adopted the enrichment of CO_2. For checking humidity 49.17 percent of respondents had adopted a hygrometer. 59.17 percent of respondents had followed root media preparation properly. 79.17 percent of respondents had adopted a mist and sprinkler irrigation systems findings are in line with Dinkar P.S, (2016)[12]. Other aspects like soil testing (pH &EC) 81.67 percent of respondents had adopted. Only 35.83 percent and 38.33 percent of respondents had adopted thermometers and plastic polyethylene mulching respectively. In post-harvest management techniques, maturity indices and harvesting were properly adopted by 93.33 percent of respondents. The possible reason for attaining a 93.33% adoption rate is probably because farmers need to harvest at the correct stage for exportation purposes. 57.5 percent of respondents had adopted grading and packing practices. 56.67 percent of respondents had adopted a pre-cooling unit for increasing the shelf life of flowers.

Adoption level of special horticultural practices for cut flower cultivation

Table 3a. Adoption level of special cultivation practices in rose **n=42**

S. No.	Special cultivation practices	Number	Percent
1	Pruning (march-October)	42	100.00
2	Disbudding	23	54.76
3	De-suckering	40	95.23
4	Bending	03	07.14
5	Defoliation	24	57.14
6	Bud Capping	42	100.00
7	Soil loosening	25	59.52

From Table 3a, it is evident that all the farmers (100%) adopted pruning and bud capping as these are well-known practices in rose cultivation. Consequently, these practices were adopted by all the growers. However, only 7.14 percent of the farmers adopted the practice of bending. This low adoption rate can be attributed to the lack of awareness among most farmers regarding the benefits of bending and their limited knowledge of this practice.

Table 3b. Adoption level of special cultivation practices in Carnation n=33

S. No.	Special cultivation practices	Number	Percent
1	Training (Netting)	33	100.00
2	Calyx banding	09	27.27
3	Pinching		
	Double pinching	04	12.12
	Single pinching	26	78.78
	Pinch and half	03	09.09
4	disbudding	17	51.51
5	De shooting	22	66.67
6	Tinting	01	03.03

Table 3b represents the high adoption rate of netting among all carnation farmers (100%) which can be attributed to its crucial role in carnation cultivation, providing essential protection to the plants. Additionally, the majority of growers (78.78%) adopting single pinching indicates the widespread recognition of its effectiveness in stimulating increased flower production, while the relatively low adoption rate of calyx banding (27.27%) and tinting (3.03%) may be due to limited awareness or knowledge of these practices among carnation growers.

Table 3c. Adoption level of special cultivation practices in Chrysanthemum (n=22)

S. No.	Special cultivation practices	Number	Percent
1	Staking	22	100.00
2	Pinching		
	Soft pinching	18	81.81
	Hard pinching	04	18.18
3	Disbudding	09	40.90
4	Lighting	22	100.00
5	Darkening sheet	22	100.00

It can be observed from Table 3c, that all the farmers adopted stalking, lighting, and darkening sheets, as these are the standard practices for chrysanthemum cultivation. Therefore, all the farmers adopted these practices. The majority (81.81%) adopted soft pinching only, as it is easier than hard pinching and helps promote bushier growth.

3.3. Overall adoption level of protected cultivation technologies by each category of adopters

Weights for each protected cultivation technology adopted by cut flower growers were calculated through principal component analysis. Cut flower growers adopted several technologies under protected cultivation, from that enrichment of CO_2 (0.0539) and integrated pest management practices (0.0524) recorded the maximum weights and maintaining air space between two covering materials (0.0162) the least. Calculated composite technology adoption index (CTAI) for all cut flower growers using the weights obtained by PCA**.** The technology adoption index (TAI) ranges between 0.09 to 0.99. Then the adoption level of each category of farmer is calculated using mean and standard deviation.

Table 4. Distribution of adopter categories according to their composite technology adoption index (CTAI) n=120

S. No.	Adoption level- CTAI	I	EA	EM	LM	L	Total
1.	Low (< 0.29)	0 (0.00)	0 (0.00)	10 (37.03)	6 (22.22)	11 (40.74)	27 (22.5)
2.	Medium (0.29-0.93)	2 (3.07)	6 (9.23)	29 (44.61)	20 (30.77)	8 (12.30)	65 (54.17)
3.	High (> 0.93)	4 (14.2)	10 (35.71)	10 (35.71)	2 (7.14)	2 (7.14)	28 (23.33)
Mean: 0.61 & SD: 0.32							

(I-Innovators, EA- Early Adopters, EM- Early Majority, LM- Late Majority, L- Laggards)
(Figures in parenthesis represents percentage)

It is evident from Table 4 that in general, a vast proportion of the cut flower growers had (CTAI 0.29- 0.93) medium level of adoption. Ruli, Goudappa *et.al.,* (2022)[13], Singh B. K. *et.al.,* (2016)[14] and Shivaramu, K *et.al.,* (2019)[15] have also reported similar results. All the innovator and early adopter categories possessed medium to high levels of adoption. 35.71 percent of early adopters and the early majority had a high level of adoption, followed by, innovators (14.28 %). And 7.14 percent of late majority and laggards also had a high level of adoption. There was an increased tendency of adoption among the laggard category but the delay in adopting was caused by the inadequacy of financial resources.44.61 percent of the early majority possessed a medium level of adoption. 30.77 percent of late majority had a medium level of adoption, followed by laggards (12.30%), early adopters (9.23%), and innovators (3.07%). The majority (40.74%) of laggards had a low level of adoption, followed by the early majority (37.03%), and the late majority (22.22%). The results are similar to the findings obtained by Prema (1994)[16].

4. CONCLUSION

The study revealed that the majority of cut flower growers belonged to the early majority category in the adoption of protected cultivation technologies. This is primarily due to various governmental incentives offered, such as financial aid, technical training, and tax breaks, which have enticed people to promptly adopt protected cultivation technology. Both central and state governments provide schemes to implement protected cultivation practices among cut flower growers. Despite that, the majority of cut flower growers had only a medium level of adoption. To increase the level of adoption, it is suggested that institutional support should be increased. Most farmers adopted protected cultivation through the NHM scheme, which provides subsidies solely for constructing the protected cultivation structure. However,

certain cultivation practices like light control, greenhouse cooling, and pest management are also very cost-intensive. Therefore, farmers suggest that equipment used for these cost-intensive practices should be provided at a subsidized cost.

Limitations:

The findings of this study might not be applicable to other cut flower growers using protected cultivation techniques because of the localized nature of the climatic conditions and farmers' characteristics in the study area.

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